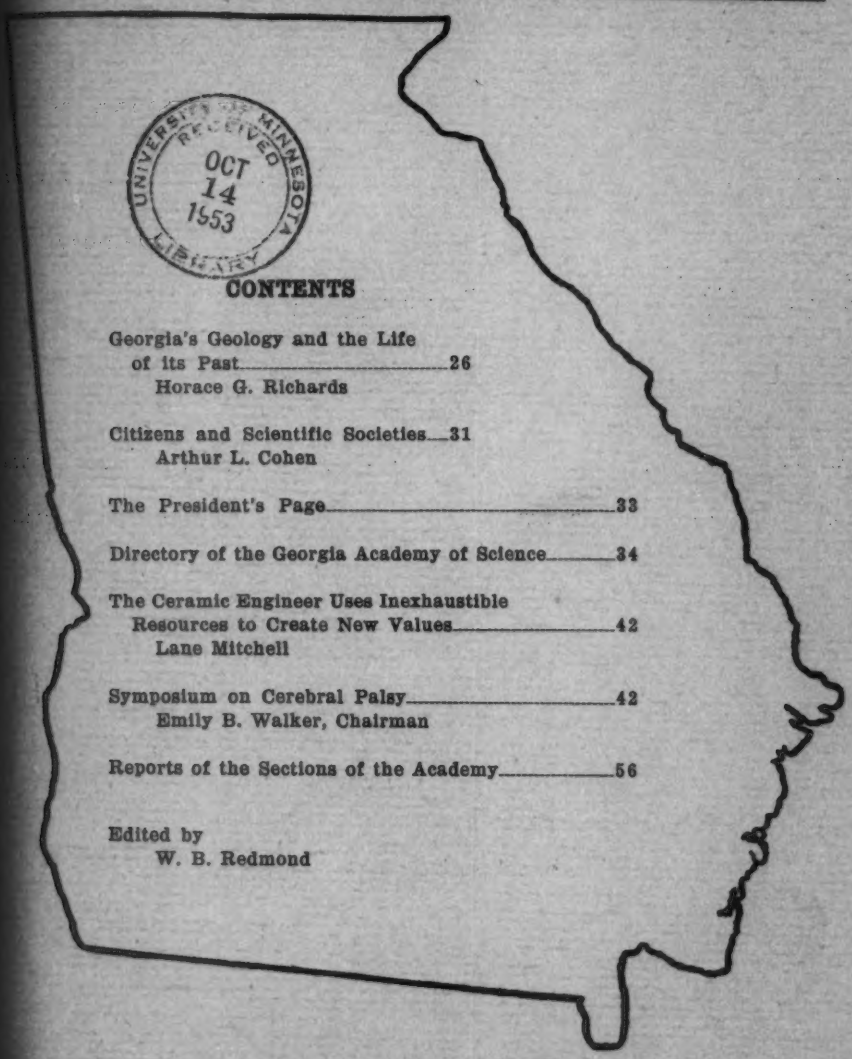
BULLETIN *of*
The GEORGIA ACADEMY *of* SCIENCE

Volume XI | June, 1953 | Number 2



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Edited by
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THE BULLETIN of the GEORGIA ACADEMY OF SCIENCE is published four times each year, in April, June, September and December and is sent without charge to all members of the Academy.

Articles to be published in the BULLETIN should be sent to the Secretary, Box 534, Emory University, Georgia. Reprints of articles will be furnished at cost.

GEOLOGICAL TIME TABLE

Era		Period or Epoch	Years ago (to beginning of period)	Popular Name
Cenozoic	"Quaternary"	Recent	12,000	Age of Man
		Pleistocene	1,000,000	Ice Age
	"Tertiary"	Pliocene	12,000,000	Age of Mammals
		Miocene	28,000,000	
		Oligocene	40,000,000	
		Eocene	60,000,000	
		Paleocene	70,000,000	
Mesozoic		Cretaceous	130,000,000	Age of Reptiles
		Jurassic*	155,000,000	
		Triassic	185,000,000	
Paleozoic		Permian*	210,000,000	Age of Coal
		Pennsylvanian	250,000,000	
		Mississippian	265,000,000	
		Devonian	320,000,000	Age of Fishes
		Silurian	360,000,000	
		Ordovician	440,000,000	Age of Invertebrates
		Cambrian	520,000,000	
Proterozoic Archeozic		Pre-Cambrian	2,000,000,000+	

* No deposits of this age known from Georgia.

GEORGIA'S GEOLOGY AND THE LIFE OF ITS PAST[1]

Horace G. Richards
Academy of Natural Sciences
Philadelphia Pennsylvania[2]

Just as a historian tries to interpret history by reading old written and printed records, so does a geologist try to interpret the prehistory of a region by the records of the rocks and the scenery. Whereas a historian thinks in terms of years and centuries, a geologist employs the concept of millions of years and geological periods.

Much that is now land was at one time beneath the waters of an ocean. These ancient seas have left direct evidence of their existence in the form of sediments and fossils, all of which help in the interpretation of the past.

Regions that are now mountainous were once flat or beneath the sea, while ancient mountains which were in existence for millions of years have weathered down to a level plain, or completely disappeared beneath the present seas. Volcanoes once active have long since become extinct and completely weathered away.

The story about to be unfolded has been compiled from many sources. For purposes of simplification, much has been left out, and certain complicated events, such as the rise of the Appalachian Mountains, have been greatly simplified. It has also been necessary to go outside the State of Georgia to obtain evidence to fill in certain of the gaps in the geological history of that state.

Physiographic Provinces

Georgia can roughly be divided into four physiographic provinces. The part of the state lying south of a line drawn through Milledgeville and Macon to Columbus is called the **Coastal Plain.** This region is generally gently rolling or flat although there are a few low hills near the western edge. The Coastal Plain is made up primarily of unconsolidated sands and clays of Cretaceous, Tertiary and Pleistocene age. (See table, page 25). North of the Coastal Plain, and separated from it by the **Fall Line** or **Fall Zone,** is a broad belt, generally made up of crystalline and granite rocks of Pre-Cambrian or Paleozoic age, known as the **Piedmont Plateau** or **Central Upland.** Northeast of the Piedmont Plateau, and merging into it is the **Highland** or **Blue Ridge province,** also made up of Pre-Cambrian rocks. This comprises the most scenic part of Georgia. The extreme northwestern part of the state is called the **Appalachian Valley,** and is made up of a series of valleys and ridges of Paleozoic rock.

Pre-Cambrian

The beginning of the geological history of Georgia, as is the case in other parts of the world, is shrouded in mystery. Possibly an ancient sea covered parts of northern Georgia, but all records of it have been destroyed. There was undoubtedly a great deal of igneous or volcanic activity which caused any sedimentary rocks laid down in the region to have been completely changed or metamorphosed to the present crystalline rocks of the Piedmont and Blue Ridge provinces.

Some of these Pre-Cambrian rocks are of great value today because they contain gold, graphite, mica, magnetite, talc and other valuable minerals.

Little is known about the life of the Pre-Cambrian from any part of the world, and no fossils of this age have been found in Georgia. Dark carbonaceous slates and graphite schists occur suggesting the presence of some primitive organisms. Life probably consisted merely of simple plants and soft-bodied invertebrates such as worms, sponges, jelly-fish and a few brachiopods (or lamp shells).

Paleozoic[1]

Cambrian. At the beginning of the Paleozoic era, high mountainous land extended along the Atlantic seaboard from New England to Florida. Geologists have given the name Appalachia to this land mass which has now completely eroded away. During early Cambrian time the low land immediately to the west of Appalachia was invaded by a shallow sea which extended all the way from

1. Based on illustrated address given before the Georgia Academy of Science, Mercer University, Macon, Georgia, April 24, 1953.
2. Also, Lecturer, University of Pennsylvania.

1. See Geologic Map of Georgia for distribution and location of these rocks.

Alabama to Newfoundland approximately along the line of the present Appalachian mountains. Sediments were carried down by streams from Appalachia to this inland sea. At first these streams were swift and carried coarse material (e.g. Weisner Quartzite in Barton County), but gradually finer and finer material was deposited as the continent of Appalachia was slowly eroded down. Consequently limestones and shales were deposited during middle and late Cambrian time.

Most of the eastern half of the Valley province of northwest Georgia is made up of Cambrian rocks, for example, in the vicinity of Cartersville, Rome, Summerville and Chatsworth.

The life of the Cambrian seas was prolific and included such creatures as jellyfish, snails, cystoids (relatives of the sea urchin), worms, brachiopods and trilobites, the latter being the most conspicuous. Brachiopods and trilobites are occasionally found in the Cambrian rocks of Georgia, especially the Conasouga shale, although they are not as common here as in other parts of the country.

Ordovician. As in Cambrian time, only the northwestern tip of Georgia was covered by the inland sea during the Ordovician. It is probable that the seas withdrew entirely during the early Ordovician, for there is a significant unconformity between the Cambrian and Ordovician deposits in the state. The Ordovician deposits of Georgia consist mostly of limestone and can be seen near Chatsworth, LaFayette and Summerville.

Far to the north of Georgia an extensive mountain range appeared during the late Ordovician. This process of mountain building was called the Taconic Revolution and was especially evident in New England and New York State. It is known that there were numerous volcanoes in eastern North America at this time, and the presence of thin layers of volcanic ash (bentonite), interbedded with Ordovician shales in Dade and Walker counties, suggests that some of the volcanoes may have been as far south as Georgia.

The life of the Ordovician seas was more varied than that of Cambrian time. Among the forms to appear for the first time were corals, clams and nautiloids, strange creatures, both coiled and straight, that were the remote ancestors of the present-day "Pearly Nautilus." Fish first became conspicuous, although no fish fossils have yet been found in the Ordovician rocks of Georgia. Trilobites, brachiopods and corals were the dominant animals of Ordovician seas. Abundant Ordovician fossils have been collected from the Murfreesboro, Lebanon, Lowville and Trenton limestones in northwest Georgia.

Silurian. The inland sea continued to cover northwestern Georgia during early and middle Silurian time, but completely withdrew during the late Silurian. During middle Silurian time, the Red Mountain formation was laid down in Alabama and northwest Georgia and contained great quantities of iron ore (hematite). This iron probably formed in shallow bays and lagoons along the margin of the inland sea. This iron deposit is known as the Clinton group and occurs from New York State to Alabama. In Alabama, especially near Birmingham, it is of great economic importance and may be as much as 18 feet in thickness. In Georgia it is rarely more than three feet in thickness and occurs in White Oak Mountain and Taylor Ridge east of Summerville.

Silurian fossils include reef-building corals, graptolites (small floating organisms), brachiopods, mollusks, nautiloids, trilobites, sea scorpions (eurypterids), and fish, not all of which, however, have yet been found in Georgia.

During late Silurian time, the seas withdrew from much of the continent, and left a series of great salt lakes or bays, probably connected to the open sea by narrow straits. These were especially numerous in New York, Ontario and Michigan and are the origin of great salt mines in those areas today.

Devonian. There are no records of early Devonian rocks in Georgia. This can be explained by either of two possibilities: (1) the seas did not cover any part of the state during that time, or (2) the deposits left by the early Devonion sea have been eroded away. During Middle and Late Devonian time, however, the seas again covered northwestern Georgia and a few deposits of chert and shale are known from the region. The Armuchee chert occurs

in Horseleg Mountain, at the north end of Mount Alto near Rome, and Turke Mountain, and three-quarters of a mile northwest of Gore. Corals and brachiopods are common in this formation.

The Chattanooga shale unconformably overlies the Armuchee chert and can be seen at a few outcrops in northwestern Georgia, for example, at Crystal Springs in Floyd County and at the north end of Mount Alto one mile south of West Rome. Fossils are very few, and it is possible that the Chattanooga shale is actually of Mississippian age.

Fishes were abundant in Devonian seas, although few if any have been found in Georgia. Land plants, which had first appeared during the Silurian, were widespread, while the land animals (insects and amphibians) made their first appearance.

Mississippian. By Mississippian time the northern part of the inland sea (geosyncline) was largely filled with sediment washed down from the land mass of Appalachia. Therefore, coal swamps, estuaries and delta took the place of the open sea in that area. However, open seas still covered northwestern Georgia and great quantities of limestone were deposited; a few shales and cherts also were formed. Fossils are not common but include corals, crinoids, blastoids, bryozoa, and brachiopods.

Pennsylvanian. The inland sea was almost entirely filled with sediment by Pennsylvanian time and consequently great swamps existed in deltas from the Maritime Provinces to Alabama. The abundant vegetation of these swamps has given rise to the coal of the Pottsville and other formations of similar age. Coal of Pottsville age (early Pennsylvanian) has been mined at various times in extreme northwestern Georgia. Not all of the Pottsville formation, however, is coal. Most of it consists of thick, hard, non-marine sandstone which forms such flat topped ridges today as Lookout Mountain and Sand Mountain.

The vegetation of the coal swamps included such plants as the giant scale tree, true and seed ferns and calamites (giant rushes). Animal life included giant insects, amphibians and a few reptiles, although none have been reported from Georgia.

Permian. By Permian time the great quantities of sediment washed into the geosyncline had become so thick (probably as much as 30,000 feet) and were at least partly responsible for a period of intense mountain building known as the Appalachian Revolution. The uplift of the Appalachian Mountains was the natural geological reaction to the tremendous sedimentation in the inland sea or geosyncline. This uplift was accompanied by intense folding and faulting as well as intrusions of granite and other igneous rocks.

No sediments of Permian age are known from Georgia, although many evidences of Permian activity can be seen in the folds of the Appalachian Valley and the faults of the Blue Ridge provinces and elsewhere. Along one of these fault lines—the Cartersville—the older Pre-Cambrian rocks were thrust on top of the younger Paleozoic rocks along a line more than a hundred miles in length.

Many of the granites of Georgia were intruded at this time (e.g. Stone Mountain), although it is possible that some appeared during the early Paleozoic or Pre-Cambrian. The original Appalachian Mountains were high and majestic and rivaled the present Alps and Himalayas in grandeur. Later erosion and peneplanation together with minor uplifts have reduced them to their present form.

Nothing is known about the life of Permian time in Georgia. Elsewhere, Marine life was gradually becoming more modern in appearance with the extinction of the trilobites and the rise of the mollusks. On land, the reptiles were beginning to dominate the scene, although the dinosaurs themselves had not yet appeared.

Mesozoic

Triassic. At the beginning of the Mesozoic era, Appalachia had been weathered almost to a plane, while the newly uplifted Appalachian Mountains had begun to erode down. Normal faulting caused a series of inter-mountain basins to appear along the east coast from the Maritime Provinces to South Carolina, and probably Georgia. No positive evidence of Triassic sediments are known from Georgia, thus Triassic fossils are unknown from the State, although elsewhere the period is marked by the rise of the dinosaurs and other reptiles. Some shales at the bottom of deep wells in south

Georgia and northern Florida may be of Triassic age. Vulcanism and other igneous activity also took place during Triassic time, although again most of the evidence comes from farther north. However, numerous dikes of Triassic age are known to crosscut the other crystalline rocks at various localities in Georgia.

Jurassic. The ancient continent of Appalachia was completely eroded by Jurasic time, while the uplifted Appalachian Mountains had begun their long process of peneplanation with the sediments being carried beyond the limits of Georgia. Consequently, no sediments of Jurassic are known from the state. The Jurassic seas covered parts of Coastal Plain Alabama, but may not have reached the Georgia border.

Cretaceous. By Cretaceous time the Coastal Plain of Georgia was being invaded by a sea advancing from the east. At first, relatively little of the Coastal Plain was submerged, and the sediments deposited were largely terrestrial or fluvial. As time went on the sea advanced farther, with probably some temporary retreats, so that the late Cretaceous deposits are largely of marine origin. The beginning of the late Cretaceous still saw much of the Coastal Plain above the water as shown by the predominately non-marine character of the Tuscaloosa formation as exposed near Augusta, Macon, Columbus and elsewhere just east of the Fall Line. Fossil plants are known from a few localities in Georgia and South Carolina, while marine fossils are known from the formation in wells, indicating the sea covered parts of the Coastal Plain during some phases of deposition of the Tuscaloosa formation.

As late Cretaceous time continued, more and more of the Coastal Plain of Georgia was submerged. Five formations have been recognized which are predominately of marine origin. These are the Eutaw, Blufftown, Cusetta, Ripley and Providence. Fossils are abundant at many places along the Chattahoochee River, especially between Columbus, Georgia, and Eufaula, Alabama.

The life of the Cretaceous seas included many oysters, clams, snails, ammonites, sea urchins and other forms. The land life included dinosaurs, large turtles and other reptiles, as shown by fossils found in Georgia and nearby states. The flowering plants were of genera and families that are still living today.

Cenozoic

Paleocene and Eocene. The sea advanced and retreated over the Coastal Plain of Georgia several times during the Paleocene and Eocene. At least once the seas overlapped over the Fall Line onto the Piedmont Plateau. Several different Eocene formations have been recognized, the most important being Clayton (Paleocene), Wilcox, McBean and Ocala (oldest to youngest). The bauxite deposits at Andersonville, are believed to be part of the Clayton formation. Eocene fossils, especially various species of oysters, have been found at Fort Gaines on the Chattahoochee River, at Shell Bluff on the Savannah River and at numerous other localities. The upper Eocene deposits of Alabama contain fossils of large whale-like mammals known as Zeuglodon, and it is probable that such creatures also lived in Georgia waters during Eocene time.

The Age of Reptiles was over, although a few such as the turtles, crocodiles, snakes, etc., have survived to the present day. The Eocene marked the beginning of the age of mammals, although because of the marine nature of the deposits, few if any mammal fossils have been found in the Eocene sediments of Georgia.

Oligocene. The seas withdrew and then submerged much of the Coastal Plain again during part of Oligocene time. The Flint River and Suwanee formations were laid down in the Oligocene seas and fossiliferous outcrops of this age can be seen near Bainbridge, Oakfield, and Thomasville.[1]

Miocene. During early Miocene time the seas advanced over parts of the Gulf Coastal Plain and parts of southern Georgia forming the Tampa limestone. Farther north the land was high and there was probably a cape in the vicinity of present Cape Fear. North of this, the seas submerged extreme eastern North Carolina (Trent marl). Only a few fossils are known from the lower Miocene of Georgia, at Wylie Landing on Flint River, 3½ miles north of the Florida line.

1. The Cooper marl is regarded by some as Eocene, by others as Oligocene.

During Middle Miocene time the seas probably covered somewhat more of Coastal Plain Georgia, but very few fossils are known. Parts of Florida and probably Georgia were above water during this time (Hawthorne) for a small fauna of land vertebrates including the camel, rhinoceros, horse, dog, some rodents and an oreodont, have been found in Gasden County, Florida. Fullers earth and phosphate are present in rocks of the Hawthorne formation. The former is mined near Attapulgus, Decatur County and Ochlockonee, Thomas County, but commercial phosphate deposits have not been found thus far in Georgia.

Submergence in Georgia during late Miocene times was probably limited to the extreme coastal region, although a much greater submergence took place farther north drowning the "Cape Fear uplift." Deposits of the late Miocene age in Georgia (Duplin marl) are limited to bluffs along the Savannah River near Porters Landing, and along the Altamaha near Doctortown.

Pliocene. Early Pliocene time was marked by a slight submergence of the land along the margins of the present shore line. The Charlton formation is known from a few outcrops along the St. Marys and Satilla Rivers. During late Pliocene time the land was high and the seas far beyond their present shoreline. The Appalachian mountains were probably re-elevated at this time causing extensive deposits of gravels to be spread out near the western edge of the Coastal Plain as well as on the Piedmont.

Pleistocene. During the next episode great ice sheets advanced far south of their present location, but not as far as Georgia. That the climate was colder than now is indicated by the presence of fossil larch in deposits near Dahlonega, Georgia. There were four major advances of the ice separated by three interglacial stages. During the glacial stages, the climate was cold and sea level was lower than now, because the water was locked up in the form of land ice. During the interglacial stages the climate was warm and sea level was higher because of the melting of the ice sheets. Unfortunately, direct evidence of only one interglacial stage can be found in Georgia. During the last, or Sangamon stage, sea level was about 30 feet higher than now causing marine deposits to occur on land less than 30 feet in elevation. Marine fossils indicating a warm climate have been collected near Savannah, Brunswick and elsewhere along the coast.

In 1838 Charles Lyell reported the fossil remains of two species of ground sloth, the elephant, mastodon and tapir from dredgings from the Brunswick Canal. All of these must have lived in Georgia during one or more phases of the Pleistocene. It is probable that a very extensive land fauna lived in Georgia at this time for the fossil remains of many animals including the sabre-toothed tiger, horse, tapir, mammoth and mastodon have been found in Pleistocene deposits of Florida especially near Vero and Melbourne.

Recent. The last ice sheets began to retreat from their southern limit in New York State about 12,000 years ago. From then to the present day the sea has been intermittently rising causing the formation of the present Georgia coast line. Sometime during this stage man appeared on the scene, probably migrating from the southwest part of the United States. But here we come to the end of the geological record and the beginning of recorded history.

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CITIZENS AND SCIENTIFIC SOCIETIES[1]

Arthur L. Cohen
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It has been my proud honor to have served the Georgia Academy as a general officer for nearly two years, and in that time I wonder if I do not take with me more than I put in. There are the friendships I have formed which would not have occurred otherwise; there is the great—the very great—help so many of you have given on such very short notice; and there is a whole world of rich experience and impressions which I have been able to claim in these years.

For several months I have been trying to sort these impressions, to see if I could discern patterns and trends among them; and to try if possible to relate them to situations outside the Academy activities in a strict sense. There seems to be several tendencies growing in importance today, some good in the promotion of scientific endeavor, a few inimical. It is these trends which I wish to mention. Time does not permit a full discussion of them here, but the marking of these currents of activity and thought may in itself be of value to those who can chart them more fully.

The concepts which motivate scientific academies are changing rapidly. There was a time when a state academy was an austere retreat of somewhat aged Olympians, people well deserving the term academician. That was surely the actual case with many academies, and may still be true of some. My friends tell me that the Georgia Academy used to be imbued with the same remote spirit.

This was a spirit perhaps exemplified by academies but not confined to them, for scientists generally tended to view the pursuit and the teaching of science as completely self-contained ends. The Second World War hurried the tendency to break away from this inward-turned view. Under the pressure of war, traditional barriers between pure and applied science and between the fields of science crumbled away. Plant physiologists found themselves in aviation medicine, microbiologists were doing rubber research, physicists were doing microbiology, and there was in general a very bewildering switching of fields.

In spite of confusion of purpose and a babel of opinion, in a remarkably short time the main tendencies came into relief. First was the interpretation of science and society. Not only technology, but scientific concepts were taken and sometimes dragged legitimately and illegitimately into politics. Since many people almost overnight had to learn new techniques, new subjects, and new habits of thought, they also acquired new outlooks. This was all to the good when it discovered relations between various fields, it was rather a mixed blessing when some of these outlooks implied, for example, that all scientific problems could be solved by organization and teamwork of the sort used in military operations.

That cooperative enterprises accomplished much which could not be done by the individual scientist would be foolish to deny. There are fields in which research teams are not only desirable but absolutely necessary, as in some aspects of biochemistry and certainly in nuclear physics. Yet it is a human—and perhaps particularly an American—trait to apply a method or an approach wholesale and uncritically once it has been shown to work in any particular area. We have witnessed the illegitimate extension of the research team into regions where the crying need is for creativity—for ideas. Possibly this trend is now being reversed or at least abating. The traditional activity of an academy of science—the free interchange of ideas and the mutual stimulation may serve well here to allow the scientist to ex-

1. Based on the address of the Retiring President of the Georgia Academy of Science, Mercer University, Macon, Georgia, April 24, 1953.

press his individuality and to develop his ideas. All research is based on ideas, and although the individual may be stimulated to express ideas by others, it is still the individual who must have and express them, whatever the role of teamwork may be later on.

While the American people continue to support research on a previously undreamt of scale, there is increasing understanding of the role of pioneer research, a developing awareness that the value of a research program is not necessarily measured by the money sunk in its equipment. I am not saying that electron microscopes are not invaluable tools in some fields of research, but there are still areas to be discovered large enough to be seen without them.

It is also happy to note that at the same time inflation is disappearing as a fashion in research, there seems to be a return to sanity in scientific education. The basic, if somewhat bewildered, interest of the citizen in science is always with us as well as his feeling that science is very important. It is the response to this interest which appears to be improving.

In the past non-professional scientific education was left largely in the hands of writers whose gift for the lurid outclassed their passion for accuracy, or it was in the hands of teachers who gave high school courses in the barest skeleton of science. In any event except on a college level, science education was certainly not considered to be worthy the attention of scientists. Scientists, even those not professionally engaged in teaching, now realize their obligation to inform the layman interestingly and accurately. The formation of education sections in various scientific societies is testimony to this obligation.

The Academy reflects the terrible responsibilities which the scientist can no longer evade—the responsibilities of a particularly informed citizen toward disseminating and directing his powerful knowledge for good and not for ill. There is the responsibility toward education—which should be an increasing access of knowledge geared to maturing competence rather than the work at cross purposes which has plagued our colleges and high schools. I hope the period is ended in which colleges try to bring students up to the level they should have reached on entering. I hope the high schools have gotten beyond the view that in a democracy equal rights mean ignoring unequal abilities. Through the Junior Academy, the Georgia Academy of Science can discharge perhaps its most important obligation—the selection from this vast levelling process of those whose potential abilities in science can be recognized and encouraged. This work is far from as complete as we would like it, but if we can point with pride to anything, we can certainly exhibit the Junior Academy proudly. But the cross currents of the educational processes represent only one aspect of the cross currents and cross purposes which plague our civilization. The necessity for conservation stems from other conflicts—conflicts which have arisen in our technologically based society and are born of science and technology itself. In the conservation of human and natural resources, it is paradoxical to see scientists employed to design processes whose by-products pollute the streams and poison the air, while other scientists and technologists work frantically to alleviate these effects. This wastage of human effort, this work at cross purposes, reminds me of the white knight in "Through the Looking Glass" who said "But I was thinking of a plan to dye one's whiskers green. And always use so large a fan that they could not be seen."

The Academy through its meetings not just of the scientifically interested from different areas of science, but of those from different fields of application, industry, education, agriculture, can do immeasurable service in promoting mutual understanding of each other's fields and problems, and in fostering mutual help. Through projects such as the Junior Academy and its undertakings, I believe there has been a significant increase in quantity and quality of scientific education.

Another sign of the changing outlook reflected in the Academy is in the formation of an Academy Improvement Committee. The purpose of this group is to seek ways in which the Academy can improve and extend its services not only to its members, but to the people of Geor-

gia generally and by diffusion eventually to the Nation.

Many problems of the relations of science and the citizen remain to be solved, some of them but dimly seen as yet.

The scientists who, with the advent of the atomic era, hesitatingly, with some feelings of guilt, of rawness, tried to say something about the use of this terrible power, about its social and political significance, felt that they were entering an unknown field somewhat presumptuously. Unfortunately, the same difference and humility has not burdened lawmakers who have felt themselves competent to investigate, intimidate, and censor. Lionhearted courage has not exactly marked their colleagues who, we hope, disapprove of these bumptious antics. None of us wants to see science invade politics. What can we do when we see politics invading science?

Our Academy is non-political. No matter what the commitments of its members are individually, what ties and pressures restrain each of us, as a body we are committed only to the furtherance of science and to the furtherance of human welfare through science. By virtue of the fact that as a corporate body we come with clean hands, we can as a body fight the subversion of science in the name of antisubversion, and the restriction of freedom of thought and inquiry in the name of democracy. We are fortunate that there have been few signs of this in Georgia, and I hope the present wave of perilous foolishness will destroy itself before there is immediate danger here. I believe the Academy can render great service to science, to the people of Georgia, and to freedom of thought in general by a positive program of information and education so that the growth of knowledge and understanding will be too sturdy to allow the growth of the weeds of misplaced politics and wilful ignorance.

In conclusion we are doing and we can do more to:

Inspire and encourage each other through our Annual Meetings and publications.

Bring our knowledge to the service of the citizens of our state.

Fight attempts to throttle, twist, and pervert the free flow of scientific truth and opinions.

And lastly and most important, seek and encourage talent and interest among our youth.

THE PRESIDENT'S PAGE

The Manufacturing Chemists Association has recently published a "fact book" entitled "The Chemical Industry." In it is illustrated the rapid growth of the chemical industry. The fact is pointed out that the productive capacity of the chemical industry is increasing at a faster rate than the number of chemists and chemical engineers available. No doubt, this same condition exists in other scientific fields.

The Georgia Academy of Science is encouraging interest in science by high school students thru its sponsorship of the Junior Academy of Science, the Science Fair and Talent Search. This responsibility should be shared by a greater number of scientists in the State of Georgia.

Membership in the Georgia Academy of Science is initiated by nomination by two members. Enclosed with this issue of the BULLETIN are two membership blanks. There are many in Georgia who qualify for membership as "Residents of Georgia who are engaged in scientific work, or who are interested in the development of science." If every member will cooperate on this project, a stronger Academy, capable of greater accomplishments, will result. Please help the Membership Committee by nominating qualified persons for membership in the Academy.

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THE CERAMIC ENGINEER USES INEXHAUSTIBLE RESOURCES TO CREATE NEW VALUES

Lane Mitchell, Director
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Atlanta, Georgia

Ceramic Engineering training is for men who will control industrial output of ceramic wares. The ceramic engineer is not necessarily or usually an artist as many people suppose. The ceramic artist is differently trained to create, design, and decorate.

The ceramic engineer is first of all an engineer. As such he applies mathemaaical, physical and chemical laws to fundamental raw materials and produces from them products useful to man. His special field is non-metallics and his special training is in high temperature treatment of these non-metallics. Thus ceramic engineering stands side by side with agriculture as the most fundamental of professions—using the vast resources of the earth itself to create new values and thus raise man's standard of living continuously to a higher level.

The earth itself, being the inexhaustible storehouse of ceramic raw materials makes the field of ceramics eternal. The first humans who used fire developed a ceramic industry with their primitive manufacture of pots and bricks. Down through the ages man has measured his rise in civilization with his development and use of ceramic products.

The awesome spectacle of a new age is upon us as atomic energy becomes available to man. Ceramic Engineers will use much atomic energy to change earthly materials into fabulous new products or to produce older products or structures by ceramic means.

Today the Ceramic Engineer may be concerned with production, testing, and research problems involved with products such as brick and tile, dinnerware, sanitary ware, electrical insulators and dielectrics, abrasives, portland cement, heat insulation, light weight aggregate, vitreous enamel coatings on metal, glass of all kinds and refractory linings, crucibles, retorts, and furnaces.

Tomorrow the Ceramic Engineer may be concerned with paving roads with molten glass, building tunnels by molting the earth away, or with creating vast solid objects from the raw materials of the earth cooked with atomic energy.

To this end the student of ceramic engineering studies the traditional engineering subjects such as mathematics, physics, general chemistry, mechanics, heat transfer, drawing, and thermodynamics. On this structure he superimposes a knowledge of geology, mineralogy, physical and colloidal chemistry, pyrometry, and specialized ceramic processes.

The engineer thus trained is an excellent mechanical or civil engineer for the ceramic industries and his specialization makes him uniquely qualified for leadership in many mineralogical, chemical, or process fields.

The Potter as a symbol of the ceramic engineer is as outdated as is the chariot a symbol of modern warfare. Truly the Ceramic Engineer of today is a builder of the World of Tomorrow!

SYMPOSIUM ON CEREBRAL PALSY

Psychology-Medicine Section
Chairman: Emily Barry Walker, Emory University School of Dentistry

This symposium was given as a part of the program of the Psychology-Medicine Section of The Georgia Academy of Science at its annual meeting, April 24-25, 1953, Macon, Georgia.

The program was as follows:

I. Research in Cerebral Palsy—Emily Barry Walker

II. Present Day Concepts in the Training of the Cerebral Palsy Child—Martha Schnebly

III. Psychological Problems of Cerebral Palsy—Florence M. Young

IV. Speech Development in the Cerebral Palsied Child—Mary Rose Costello

V. Problems of a Dentist with the Cerebral Palsy Child—Chester Lloyd

VI. Drugs used in the Treatment of Cerebral Palsy—James L. Morrison

VII. Neonatal Asphyxia and Brain Injury—Faith S. Miller

RESEARCH IN CEREBRAL PALSY

Emily Barry Walker

Cerebral Palsy for the purpose of this discussion, is defined as the disturbance of motor function due to damage to the brain before, during or shortly after delivery of the infant. It may also be caused by developmental disturbances during the early stages of pregnacy.

The purpose of these studies was to establish the fact (i.e. a fact in a functional sense) that pathways in the brain have been disturbed and retarded due to prenatal or postnatal injury.

The clinical material for the study was that of two celebral palsy cadavers sent in by the Anatomical Board of the State of Georgia. The evidence of muscular spasticity was very definite from a gross examination. The brains also gave gross evidence of injury. As the injury was evidently in the main motor area, the gray matter of the narrow rolandic strip of the anterior central gyrus, it would follow that the injury had been a birth injury.

A follow-up of the case histories likewise gave proof that the cases were those called cerebral palsy. A brief review of the case histories may help to throw light on the gross anatomy evidence.

Case 1. A colored boy, age 23. He was brought up in a city alms house to which he and his mother were admitted when he was a baby. No definite record was kept concerning his birth. He made no effort to use his lower limbs in any way although he used his arms to swing himself about—monkey fashion. He had a broad smile and beautiful teeth. He seemed to know people and showed evidence of intelligence. He made no attempt to speak nor did he masticate his food. Gross examination of his muscles of mastication showed them to be all intact. This gave the idea that it was a brain injury and not a bone or muscle defect.

The external evidence of brain injury, probably that of pial hemorrhage, extended as far down as Brocas area the motor word center for speech. This fact together with the fact that he did not speak gave a very definite indication that it was a motor brain injury.

Case II. A white boy, age 22. He lived in a hovel with his mother and grandmother, both women of ill repute. He had no ability of motion except that of moving his head from side to side. He did not make any attempt to speak and could take in only soft or liquid foods.

Gross examination showed the muscles both those of the head and of the limbs to be intact but very poorly developed. He was in an emaciated condition. An examination of his brain gave evidence of injury of considerable extent to the anterior central gyrus and Brocas area. This again gave proof that the spastic condition was due to brain injury. It was not possible to determine whether the injury was prenatal or postnatal. The doctor who officiated was not living and no record had been kept.

After completing the dissections and the gross examination it was thought that a study of the motor tracts of the brain might prove significant. The motor tracts, fibers from right to left precentral gyri, form:

1. The greater part of the corresponding (right or left) basis pedunculi of midbrain.
2. Eminences at each side of the median groove of pons.
3. Pyramids of medulla oblongata.

In the lower part of the medulla most of the pyramid fibers cross the median plane (decussation of pyramids) and disappear into the interior, to lie lateral to the gray matter of the spinal cord. The corpus callosum, the large mass that connects the hemispheres, was much diminished in this brain. The corpus callosum provides for harmonized interactions between the cortical cells of the two hemispheres and its development in the mammalia is in direct proportion to the complexity of the cerebral convolutions.

The pathways for voluntary motor impulses proceed from the cortex through the white matter of the hemisphere. Converging as they descend they form, together with fibers ascending to the cortex, a fan-like structure known as the corona radiata. The pyramidal fibers then stream through the corpus striatum forming here a compact bundle, the internal capsule. In the mid brain they occupy on each side, the middle

two-fifths or so of the base of the cerebral peduncle. In their descent through the pons they become broken up into several smaller bundles by the fibers of the pontine nuclei, but are collected together again at the lower level of the pons and continued downwards as a compact bundle or column, called the pyramid on the ventral aspect of the medulla, and in contact at the midline with its fellow of the opposite side.

The great cerebral voluntary motor tract, the tract of the upper motor neurons, commonly called the pyramidal tract, appears at the lower end of the medulla as the pyramidal decussation. The whole pyramid does not usually cross at the pyramidal decussation. The lateral fourth, more or less, runs downward on the same side of the cord close to the anterior median fissure, forming the anterior cerebrospinal tract. This is, however, only a delayed decussation, the fibers crossing one by one and the tract usually ending in the upper thoracic region. Sometimes the whole pyramid crosses at once in the medulla. More often the anterior cerebrospinal tract can be traced as low as the sacral segments. From the ventral surface of paired nuclei curved fibers called the internal arcuate fibers emerge. They start in the cells of the gracile and cuneate nuclei, and decussate with each other. Those of each side form the opposite medial lemniscus which soon becomes a structure prominent even to the naked eye in unstained sections, lying on each side of the median raphe of the oblongata between the inferior olivary nuclei. This is the relay for the long fibers of the posterior columns of the cord to the opposite side of the thalamus. It carries muscle sense to the thalamus.

A cross section of this area in Case I gave evidence of an almost complete absence of these decussating fibers.

In Case II cross sections of the spinal cord indicated an absence of fibers in the white substance.

The above facts gave evidence that the pathways of the brain were affected.

The great motor path from the cerebral cortex to the skeletal muscles is a very important factor in motor mechanism. It therefore follows that the failure of these pathways to develop or the disintegration of the fibers due to injury to the cortex areas would result in a definite failure in motor activity.

A study was also made of the corpus callosum of each of the brains in Cases I and II. This great transverse commissure connecting the cerebral hemispheres is usually a broad arched band of white fibers. In both instances there was in evidence only a very narrow portion of the upper rim of the corpus callosum. A lessening of the number of fibers would therefore indicate a lessening in the motor pathways to the motor areas.

The significance of these findings may be far reaching in our efforts to provide for increased motor activity in the cerebral palsy children. That the areas affected are those of motor reaction and sensory preception is important to an understanding, not only that muscular control is most often impaired, but also that tne impairment is functional and not in the generally understood sense, mental.

In the words of Dr. McKhann, medical director for the United Cerebral Palsy Associations, "It may well be that we are on the threshold of one or more important discoveries, or developments, through research which may change the present medical picture."

Each discovery slight as it may seem on first impression adds its part to the picture. The fact that research on the damage to the brain due to birth injuries is already under way at Columbia Neurological Institute in New York. the University of California, and the Harvard Medical School, strikes an encouraging note in the minds of those of us who have struggled for years in the dark so to speak.

Summary:

No attempt has been made to form a conclusion on these studies. The facts themselves speak for an important discovery. Of course it is necessary to examine many more brains and spinal cords from cerebral palsy victims in order to establish the facts of the missing spinal fibers, both in brain and in spinal cord.

Briefly the fibers were found to be diminished or missing in the spinal cord and no evidence of decussation in the pyramid region of the

medulla. The gross evidence of injury in the rolandic strip and Broca's area gave further significant proof of the nature of the injury resulting in motor disability.

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PRESENT DAY CONCEPTS IN THE TRAINING OF THE CELEBRAL PALSIED

Martha E. Schnebly

Cerebral Palsy being a condition of muscular incoordination arising from brain lesions, it can best be treated on sound neurological principles. We therapists are still seeking for methods of application of the present principles—while neurologists and others in research are seeking new principles to present clearer understanding of the problems and functions.

Among the present trends in treatment are the various approaches made to adapt the normal patterns of development. As one watches the growth of a baby one sees reflex patterns occurring at various levels of development, each pattern being replaced later by one of superior coordination. Some authorities refer to it as a phylogenetic development. Dr. Temple Fay has observed in animal life the developmental patterns of evolution as applied to walking. The amphibious motions are seen in a baby placed in a prone lying position. As the one upper extremity is flexed, the lower extremity of the same side is flexed. The opposite extremities are extended, the head is turned toward the extended side, the thumb of the hand of the flexed extremity is extended toward the mid line of the body. The flexed side extends with a sweeping outward movement and a reversal of the above mentioned position occurs. This unilateral posturing is replaced by a pattern which we employ for ambulation. The flexed extremity is coordinated with the opposite flexed lower extremity. When this stage of development occurs, the head turns toward the flexed arm. Only in a later period is the head maintained in the front position. These reflex patterns do not require the innervations of the new brain, but lie inherent in the spinal, bulb and mid-brain levels, according to Dr. Fay. The various levels of motor function can be related to the evolutionary growth of the nervous system. Therefore, since the cerebral palsied should be able to employ these lower reflexes, a progression of exercises has been set up based on these observations and neurological concepts. The child is placed prone lying on the table and trained first to control the side to side turning of his head. When this is actively controlled by the child and can be done rapidly—about one second—the arm motions are introduced and these are coordinated with the head rotation. Lower extremity flexion and extension and head rotation are trained next, then gradually all three are brought into proper relationship. From prone position, the child is brought to quadruped then biped stance and balance. This progression is not accomplished as easily as these words make it appear in these statements, for during the training a simultaneous program of conscious relaxation of the inactive extremities must develop. Attention is placed on controlled and coordinated movements.

Using the same developmental principles, the coordination of the upper extremities for skills must begin with the gross motion of grasp when the forearm is pronated, trained to a mid position and later to supination. The head rotation that reflexly assists flexion and extension of the elbow can be used advantageously by placing the child's ac-

tivity in such a position that the head turns to look at the activity when the elbow is flexed. This principle can be adapted successfully with some children to begin a self-feeding program. Gross grasp should gradually be replaced by the more difficult action of finger grasp employing the use of the second digit and progressing to the first digit.

Another reflex pattern has been utilized in training of the cerebral palsied through the use of resistance given in the direction of muscular contraction. Here the stretch reflex of the spastic muscle is prevented from a sudden movement but allowed to use maximum inhibitory impulses of the stretched muscle. In writing, a weight attached by ropes to a forearm cuff and allowed to hang over the edge of the table opposite the dominant hand gives the resistance to elbow extension and employs the reflex action.

Dr. Herman Kabat has been working with his therapists in establishing reenforcement techniques. Through these routines (again, based on neurological reflexes) patterns of coordinated motion can be developed. By observing man in action in daily living, Dr. Kabat became more and more aware of the body's diagonal and rotary motion. No activity is done gracefully if done only in a frontal on lateral plane. Actions take place across the body in a diagonal manner with synergistic motions rather than isolated motions. For power and control of a tennis serve, the trunk must rotate as well as the upper and lower extremities. Such mass movements as seen in this sport have been used for muscle training. Some patterns use total flexion bringing in flexion of the neck with flip of both lower extremities into action. Others stress the extension patterns. To these mass movements resistance is applied in maximum force. Other reenforcements take place by the favorable positioning of the motion, for example—flexing the elbow for wrist extension, extending the wrist to reenforce the long abductor of the thumb. Resistance can be added to the reenforcing positions until no actual motion takes place in the then supporting joints and the entire motion occurs in the distal muscle groups.

For many years principles of conscious relaxation have been used in the muscular education of the cerebral palsied. Fifteen specific modalities are established for application according to the needs of the individual child. Following a muscle evaluation to determine the status of the musculature the child's program can be adapted. Not all modalities are used in training any one child. For example, indications for massage for cerebral palsied are rather rare, but Dr. Phelps feels that heavy massage is indicated when flaccid muscles exist. Passive motions caried out by the therapists while the child consciously relaxes helps to train the concept of motion as an early procedure in muscle education. The passive motion is followed by active-assistance exercises where the therapists give only the necessary aid to let the child perform the action and still maintain relaxation. Active motion removes the assitance of the therapist and places the full motion on the child who tries to carry the motion to completion maintaining maximum amount of relaxation throughout the rest of his body. Speed is unessential early in the learning process but is added along with reciprocal action. To build muscle strength resistance is given either manually, mechanically or by the use of gravity. These several steps used to train action from a position of conscious relaxation are for some children not effective. Dr. Phelps then recommends a conditioning concept based on the Pavlovian theory. Tension and stretch reflex are disregarded in order to train in a pattern by repetition, usually a repetition set to rhythm. Reach and grasp must frequently be taught by repetition. Through relaxation and rest concepts of muscle awareness can be developed. Cerebral palsied children have muscles that are constantly contracting but with time and patience they can become aware of a muscle relaxed, they can sense the control and gradually lower the muscle tonus. Motions learned separately and now under control so that the muscles contract and relax on a more voluntary basis are combined and developed to synchronize the action of more than one joint at a time.

The effectiveness of any treatment program is finally graded according to the practical accomplishments of

the one being treated. Dr. George Deaver, being a man largely interested in the field of rehabilitation, utilizes the four basic physical requirements for daily living so builds his program around activities of walking, self-care, maximum use of hands and adequate speech. Emphasis is placed not so much on technical points of means, but on the practical points of ends gained. Patients practice doing activities they need for living, trying to devise and adapt equipment to assist. Many self-help gadgets have been the answer to problems that appeared unsurmountable and many more inventions are needed for problems yet unsolved.

Cerebral Palsied children seen in the special schools and treatment centers grow to be adults. At present opportunities are limited, but that phase of the program is beginning to receive new emphasis. Since more children are receiving care earlier in their life, they have better potentials for adulthood. Many need sheltered working conditions but they will be able to carry a share in their society. So while we improve methods by research to improve the care for the child, we must give attention to the development of skills and interests that will be of value to a member of society. Herein lies the future service to the cerebral palsied.

PSYCHOLOGICAL PROBLEMS OF CEREBRAL PALSY

Florence M. Young
Professor of Psychology
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In attempting to help cerebral palsy cases, it is important to estimate their available assets and note their deficits. Teachers and parents, and all who work with the youngsters, may benefit from this appraisal. One valuable source of information is from the use of intelligence tests.

However, great caution must be exercised in judging the intelligence of cerebral palsied children. Some have hearing difficulties, and in others there is visual impairment. Perhaps an even greater stumbling block lies in the absence or paucity of speech.

Some of the tests of mental development involve the performance of complex motor activities. Any defects in muscular control may not only retard a child's ability to learn, but seriously affect the results of conventional intelligence examinations.

To add further to the list of difficulties in testing: the child handicaped by cerebral palsy is sometimes found to have been grossly neglected. He has not had a normal opportunity to learn. Especially in testing handicapped children whose mothers are employed and away from home, it is important to ascertain whether or not the child has been isolated from, or unduly deprived of, opportunities to learn.

Another problem of perhaps equal significance arises from the results of over-protection. The prenatal period is a period of such utter dependence that we have no difficulty in thinking of mother and child as a unit. After birth, the degree of independence increases in a normal child. But when a child is handicapped, the usual development of independence is delayed. In some cases the mother unnecessarily resists the efforts of the child to stretch the apron strings. In other homes, prolonged dependency is necessitated by the degree of handicap, and the entire behavior pattern is affected. The child continues what is really an infantile status. This may definitely influence test results. One type of reaction illustrative of this is the insistence of the child that the examiner give constant help, which of course is not permissible.

It is not surprising that handicapped children seem to be more easily disturbed than normal youngsters. When the mother is sick, for instance, the effect often appears to be seriously disrupting. In testing cerebral palsy cases, therefore, it is important to ascertain the influence of factors which might produce emotional upsets.

The author has recognized the unique problems of the C.P. cases, in the process of attempting to administer intelligence tests, and some efforts have been made to adapt the materials used to the special problems of these children. For instance, the author found that the regular presentation of the vocabulary cards of the Terman-Merrill Revision of the Stanford-Binet Scale could not be used when speech was greatly af-

fected. Therefore, a multiple choice procedure utilizing four cards per trial, has been used. Not enough cases have been obtained at the several age levels to indicate equivalent scoring, but this problem is being investigated.

Other adaptations have been made experimentally. For instance, in Form L, Year II, #2, the objects have been removed from the card, because the children with poor motor coordination need to have the objects farther apart, to enable the examiner to ascertain to which object the child is pointing.

In Form L, Year IV, #4, the pictures have been pasted on a larger cardboard to increase accuracy of designation. The same was done for Geometric Forms.

For the vocabulary test which begins at Year VI (Form L) pictures were cut from "My Little Golden Dictionary" by Reed and Oswold (published by Simon & Schuster, New York). Six words from the 1916 edition of the Binet-Simon Scale are being used, thus providing a list of twenty words for pictorial presentation. The multiple choice form is employed, and the author is in the process of trying to determine the equivalent scores for the regular vocabulary presentation and the multiple choice procedure.

Regarding the mental level of cerebral palsy victims there have been numerous and varied statements. McIntire(1) has concluded that "approximately 28% of the cerebral palsied are feebleminded." On the other hand, Dr. Harry V. Bice(2) reported that 49% of his case were mentally deficient. Both use an I.Q. of 70 as the critical point below which the classification is Amentia. Dr. Bice prefers the Stanford-Binet Scale for work with cerebral palsied children.

In the present study, 97 children living in the Atlanta, Augusta and Athens areas have been tested by the author. All were diagnosed as being cerebral palsy cases by medical examiners. The results of seventeen cases were questionable, hence only 80 cases are presented in the following table.

Results of Intelligence Tests Administered to Cerebral Palsy Cases
(% of Cases)

	Bice	Young
I.Q. of 110 or more	6.6	1.3
90-109	21.9	13.8
70- 89	22.5	32.5
Below 70	49.0	52.6
Below 60	——	33.8

The mean I.Q. for the cases tested by Dr. Bice was 70.4, while that for the Georgia group was 69.1.

It was possible to retest 24 of the original Georgia cases after attendance of a special school or class for approimately one school year. All retests were made by the author. The mean I.Q. for the initial tests was 76.3 and for the retests, 81.5, a gain of 5.2 I.Q. points. If the retest of five emotionally disturbed children are disregarded, the gain is 8.1 I.Q. points.

Inasmuch as cerebral palsy cases have many and varied handicaps, the implications of which are not fully understood, it seems premature to conclude that a true picture of their mental level has been obtained. The following statements appear to be justified:

(1) The present tests, even with modifications which have been described in this paper, are perilous guides to follow in estimating the intelligence of many of these children. More adequate tests adapted to the specific disabilities of the subjects, are needed.

(2) Test results are likely to be affected by disturbances of hearing and vision, and especially by absence or retardation of speech, and by motor handicap. A child may fail specific tests because he has suffered damage which makes it impossible for him to do certain things. The validity of existing scales should be critically examined to ascertain their appropriateness for cerebral palsy victims.

(3) Such children are more likely than normal children to have had limited experience, due to handicaps, over-protection, or meagre environment. Prolonged dependency, emotional immaturity, and the effects of

(1) Syracuse University School of Education, 1952. Workshop Dealing with Problems of Cerebral Palsy, July 21-August 8, 1952, pp. 33-42. (2) Ibid.

frustration and limited social contacts, all seem to affect test scores more frequently than for normal children.

(4) Especially is it true that early test results may not indicate the true ability of the child. Special teaching methods may reveal an intelligence potential much nearer to normal than was expected.

THE DEVELOPMENT OF SPEECH IN THE CHILD WITH CEREBRAL PALSY

Mary Rose Costello

The child who has celebral palsy, we recognize as being a physically handicapped child. We can also accept the fact that a preponderant percentage of these children will have some degree of speech handicap. As all our statistics on cerebral palsy are undergoing revision, we find no agreement on the incidence of speech impairments. In a 1951 study of 467 cases 73% had speech disorders. Of these 88% had serious speech problems. Assuming that 73% represents a fairly accurate estimate of this problem among persons with cerebral palsy, it appears that speech development and correction present a very strong appeal for consideration.

An understanding of the severity of the speech involvement is increased when we realize that both the production of speech and the perception of speech may be impaired. We are aware that for the severely handicapped, it is likely no satisfactory means of expressive communication may be substituted for speech. Gesture language, inadequate and limited as it is, is hampered by physical condition and sometimes central neurological involvements. Writing or typing may be far in the future for the child with cerebral palsy, and in some instances, entirely beyond achievement. Speech reception may likewise be impaired because of conditions preventing or limiting the hearing or understanding of speech.

It is this complex problem in speech we must strive to solve, realizing that the wholesome growth of any individual is dependent upon communication with other human beings. Communication through speech is the accepted universal process. Any substitute to which the child is confined forms a barrier to normal interactions.

In considering a program in speech for children with cerebral palsy, it is of importance to realize the scope of the involvements. Many children face a multiplicity of barriers to the development of adequate oral communication.

The physical involvements are of course, of prime consideration. The normal production of speech has been described as "the most complex of all human skills," and the wonder is not that many of us speak incorrectly but that we learn to speak at all. Speech requires the neurologically synchronized activity of the muscles of respiration, phonation, and articulation. The child with cerebral palsy may have involvements in any one or all of these functions. Breathing anomalies present a serious problem. Very fine respiratory control allowing for variations in depth and timing of respiratory patterns are basic to the production of adequate speech. This control may be seriously impaired. In many instances abnormal breathing patterns exist, such as reverse breathing present with thoracic—abdominal opposition during respiration. Many of the deviate voices and arythmic utterances we hear are related to abnormal breathing patterns. Breathing may be barely adequate for life, let alone speech.

Similarly muscular control plays an important role in vocalization and articulation. In articulation, speech requires very rapid, accurate and intricate movements of the tongue, lips and soft palate. In the child with cerebral palsy, speed, movement and accuracy may all be impaired.

But speech development may be further complicated by conditions other than motor disability. Among these conditions we find looming up largely the handicapping effect of sensory defects. The role of hearing in normal speech development is generally known. Hearing impairments are present in at least 25% of these children with the highest incidence among the athetoids. Not so readily recognized is the role of vision in speech development. Yet, that it does play a part is evidenced by the very high incidence of speech defects among visually handicapped

children, double the incidence among normal seeing children. We are all aware of the numerous visual problems of the child with cerebral palsy. The role of the Kinaesthetic sense in speech has received wide recognition in recent years, particularly from speech pathologist, and with it the realization that children with cerebral palsy may lack a normal feel for muscle movement, direction, and position. This is apparent in working with spastics as well as ataxics. The simple upward movement of the tongue for the sound of "t" may not only present a problem in muscular control alone but a problem in direction as well.

In our consideration, it is also well to remember that motor problems originating in cerebral damage are frequently complicated by aphasia and intellectual disturbances. Appraxia and agnosia may be confusing barriers to a child's development in speech. Cortical damage may be preventing the comprehension or expression of speech, so that words are a meaningless jargon. The child with cerebral palsy may be so limited in learning capacity that speech would be delayed or impaired even if normal physical control were present.

No estimate of this child could be complete without a comment upon the environmental influences and their effect upon the child's development. Particularly important are the attitudes, goals, and feeling of people in this child's world. The acceptance, rejection, pressure, and stimulation he feels will affect in a vital way his total development and particularly his speech development.

A speech program, then, for any child with cerebral palsy must plan for this complexity of involvements. Speech development and correction necessitate the coordination of the knowledge and skills of various fields for objective speech prognosis and effective treatment. The decision to undertake a program in speech, the establishment of reasonable goals, and the achievement of these objectives are dependent to a large extent upon the work of other specialists. Physical and psychological evaluations and progress are an important part of the total process of speech acquirement. The speech therapist, because of the significant behavior effect of speech, is one of the most important members of a team of specialists, but she is at the same time a very dependent member of the team.

Let us first consider the determination of a program in speech for this child. In order for a speech therapist to undertake and plan a program in speech, she must have at hand certain essential information. She will need to know the type of cerebral palsy and the outlook for physical improvement, as well as specific information in speech and speech reception. A severely physically handicapped child whose physical prognosis indicates potential chewing ability, sitting balance and head control may be, from the physical standpoint at least, a good candidate for speech training. Information regarding the type of cerebral palsy is needed for the speech therapist to select muscle training procedures specific for the motor involvement. Needless to say, progress in speech is dependent to a large extent on proper bracing and the physical achievement attained by the physical therapist. The functional training of the occupational therapist is likewise of great importance.

As difficult and uncertain as psychological evaluation of the cerebral palsied is today, it is essential information to the speech therapist. A professional determination of the learning capacity, present stage of development, and prediction of ultimate growth cannot be left to subjective non-professional observation and opinion. The speech therapist needs this information to devise a teaching approach, tailor made for the child. She needs it to establish immediate and ultimate goals. It is an important factor in determining the inadvisability in some instances of ever initiating such a program. The psychologist continues to be highly assistive in the adjustment of the child in the family and community.

On our team of specialists is another person who has an important role to play, the classroom teacher in the special school. Her objective is the development of the child as a whole; her most effective instrument is speech. In a group of eight or nine children, she can expect to find from six-to-nine with defective speech. I would like to see every classroom teacher of children with cerebral palsy also a speech teacher, possesing a thorough realization of the importance of communication and

knowing the effect of this dynamic skill upon over-all growth and development. This classroom situation, be it nursery or elementary school, is the place where the force and value of speech can best be felt. I hope the future will bring the requirement that every classroom teacher of these children will also be a well qualified speech therapist.

This appraisal of the important role of related specialists in the speech development of the child with cerebral palsy does not eliminate the work of the individual speech therapist. Children whose speech is handicapped by cerebral palsy must have functional and meticulous individual muscle training programs for speech. Development of intelligible speech sounds, good breathing patterns for speech, fluency and suitable volume are the foundations upon which adequate articulation may build. Special speech development and corrective techniques for the child who is also aphasic or hard of hearing need individual study and treatment. These are some of the speech needs, individual and specific, which require constant inquiry and attention from the speech therapist. Yet attention to these needs must be tempered with the realization that she is first of all dealing with a child. Speech is only a means to an end, the happy, wholesome development of a particular child. The speech therapist, then, is concerned with general behavior changes, psychologic and physical.

No discussion of speech development could be complete without consideration of the important role of the parent. This is a relatively unexplored area and one which, I feel, holds great promise. Parents report a noticeable lack of vocalization during the months and years when the average child is preparing for and acquiring speech. Much of this lack we can attribute to physical problems in breathing and insufficient motor control. Some of it may be related to slow maturation. I feel a great deal may be due to improper or to too little stimulation. Children vocalize a great deal very early in life, even profoundly deaf babies. Hearing babies soon begin to respond to tonal inflections, pleasant and soothing, angry and disturbed. In time, they begin themselves to utilize tonal changes for personal satisfaction. Then an association process has taken place. The imitation of speech sounds normally proceeds from the child's own random babbling and later the talking of others. Children who do not hear speech show a diminishing of this vocalization and babbling as time goes on. Possibly this is a factor in the delayed attempts at speech among children with cerebral palsy. Babbling is a difficult process for this child and the vocal play of the so-called normal child is rarely present or is greatly diminished. The baby with cerebral palsy may be a quiet, good, but sometimes a rather unresponsive child. His unresponsiveness and often severe physical involvements discourage the playful talking which parents usually shower upon their children. The baby with cerebral palsy needs a daily bathing in speech during his walking hours. This stimulation should be very personal and warm, and it would seem best performed by parents. Parents need to know the value of this activity and need as well to be given encouragement to pursue it. It is a pouring in process that must go on much longer and much more systematically than with the average child.

Early diagnosis of cerebral palsy is possible today. Prediction of speech involvement is also possible in a great many instances. As part of the early program for these babies, there should be a complete understanding on the part of parents of their vital role in preparation for speech. A child learns to dress himself at a certain stage in his development. If he had not had the opportunity to practice and struggle with dressing previously, he not only probably will not achieve it at the right time, but may lose interest in performing this developmental task. It is altogether possible that the lack of interest in speech which we see in some children may be due to too little stimulation, opportunity and reward. We lose a wonderful opportunity if we do not at least give the very young child with cerebral palsy a wealth of opportunity to hear speech, as well as quick and very personal responses to his cries, laughs, and other vocalizations.

In this connection, parents deserve guidance in this early preparation for speech. They need an understand-

ing of the total process in speech development and the particular barriers their child must overcome. They need assistance in establishing for themselves and for their child reasonable ultimate goals in speech. And equally important, is the setting of small immediate objectives. It is easy to understand the overwhelming impact upon parents of the complexity and severity of cerebral palsy. Without help in establishing way stations of destination, futile effort and discouragement could result. Setting and working toward short term goals is the right and satisfying way. Parents need also to see the value of moving quickly from one achieved goal to another so that the child is constantly motivated to increased proficiency.

The speech progress of the child with cerebral palsy is a slow process. At times progress is difficult to measure. But if the efforts of all concerned can be coordinated, satisfactory progress will result. Acceptable communication can be achieved. Those engaged in this work can be constantly inspired by the challenge of adequate speech achievement . . . the most valuable skill any of us can possess.

THE PROBLEMS OF A DENTIST WITH THE CEREBRAL PALSY CHILD

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In the practice of pedodontics, the occasional patient will be encountered who varies from the so-called "normal child,' either because of a psychological impairment or as the result of a definite pathological defect. In the group commonly referred to as "abnormal,' may be placed children who are afflicted with the disease entity known as cerebral palsy. These children because of their affliction offer a decidedly greater challenge to the pedodontist and the general practitioner than the normal child. This challenge must be met by the dental profession if it is to discharge the moral and professional obligations owed to those it serves.

Management Procedures

The handling of the cerebral palsied child in the dental chair is indeed a problem in the majority of cases and in no case can it be considered as an easy task. There are means available, however, which will permit the operator to accomplish any operation which is necessary. It is not a good policy to permit the child to be held in the parent's lap and attempt to perform dental operations. Indeed, the parent is not permitted in the operating room except on the first visit, since the child will in all probabilities make some attempt to gain sympathy from the parent. Certainly the parents cannot be criticized for indulging their children, for under similar conditions anyone might follow the same pattern of over-indulgence. However, common sense and the experience of those who have handled thousands of these cases indicate that over-protection and indulgence render their rehabilitation much more difficult. In addition to upsetting both the patient and the operator, the parent will not understand some of the measures which must be used and will feel that the child is being dealt with harshly, instead of regarding them as measures to protect the child from injury.

There are two appliances which are used routinely at the Memphis Crippled Children's Hospital and in the Postgraduate Pedodontic Department of the University of Tennessee College of Dentistry that make operations on cerebral palsies, and any other child who is difficult to manage, much easier.

The first appliance is a restrainer which consists of a piece of light canvas eighteen inches long by twelve inches wide. On one of the twelve inch sides are sewn four three-foot lengths of light web belting spaced about three inches apart, and on the opposite side are sewn four buckles. On one of the eighteen inch sides, two three-foot lengths of belting are sewn six inches apart equidistant from the middle of the side. The restrainer is placed on the child in such a manner that the eighteen inch side is in a longitudinal position and the two web belts are at the top of the restrainer. These belts are passed over the child's shoulders, one on either side of the neck and tied in a slip knot to the head rest

support. The other four belts are passed around the chair and buckled to the opposite side. This will render the child's trunk and arms immobile and prevent any but the slightest movement. When this appliance is used the child cannot use the cuspidor, and it is one of the duties of the assistant to have a sputum pan nearby at all time. Experience has shown that these children will accept the restrainer much easier than they will accept being forcibly held by the assistant. In addition, the restrainer gives the child a sense of security, since it is evident to him that injury will not result from forcible contact with various articles during uncontrolled movements.

The other appliance is one designed to keep the patient's mouth open. It consists of a tongue depressor blade around one end of which several turns of cotton gauze have been placed. The conventional mouth props are not at all dependable when operating on a cerebral palsy case. They are difficult to insert, difficult to maintain and may slip at a most inopportune moment. The prop described may be used very efficiently by the assistant and will cause only minimal trauma to the child's teeth, lips and tongue. When necessary, two or three props may be used at one time to keep the child's mouth wide open and may be changed as often as necessary.

Examination Procedures

Except for certain modifications, the procedures of examination of cerebral palsy cases are the same as those applied to the normal patient. Because of the uncontrollable motion of the mandible and the sudden closure of the jaws, the operator must be certain that his fingers are not resting on the occluding surfaces of the teeth. It is wise to select as a finger rest the buccal surfaces of the teeth or the muco-buccal fold. With the tongue-depressor mouth prop in place, however, it is possible to make a thorough examination without the danger of broken mirrors and misdirected explorers. Roentgenographic examination is a difficult procedure and the operator cannot hope to attain the results possible on a normally co-operative patient. One can, however, secure roentgenograms which are of diagnostic value, even if some of the finer details are blurred. This may be accomplished by (1) having the assistant place two or three gauze wrapped tongue depresssors in the mouth and steady the head in the head rest, and (2) using a straight pair of hemostats as a film holder, place the film in the desired position. With the index and second fingers hold the hemostats in place by resting on the anterior teeth, steady the mandible with the thumb, third and little fingers.

Summary

The dental treatment of the cerebral palsied is admittedly a difficult task and will challenge both the patience and skill of the operator, however, by observing the simple suggestions enumerated above, the task need not be too difficult or beyond the scope of the average dentist. In the past this challenge has not been met, due partly to two factors:

1. Many practitioners do not fully understand the disease and the methods which may be used to cope with its dental aspects.
2. Some of the literature injects the idea that it is almost impossible for a specialist to accomplish anything with these patients, implying that such operations are totally beyond the management of the general practitioner.

It is hoped that the approach offered will be of practical value to the reader.

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EFFECTS OF HYPOTHERMIA ON NEONATAL ASPHYXIA AND ITS SEQUELAE*

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It is well recognized that the nervous system, and especially the higher centers of the brain, is extremely sensitive to lack of oxygen. Pathologists (Synder, 1949; Potter, 1952) agree that asphyxia associated with birth is the major single cause of stillbirth and neonatal death. Although lack of oxygen can be tolerated longer by the newborn than by older individuals, severe asphyxia was early recognized as a contributing factor in cerebral palsies. Recently the suspicion has been growing that more mild degrees of the condition may result in more insidious, though no less real, mental deficiencies causing behavior defects and reduction in imagination, memory and ability to solve problems.

Little, for whom cerebral palsy was long known as "Little's disease," mentioned as long ago as 1843 and stressed in 1862 the coincidence of abnormal birth, difficult labor and asyhyxia neonatorum with cerebral palsy. Case histories of children examined for neurological symptoms or behavioral problems show high incidence of asphyxia at birth. Schreiber (1938) in studying 500 patients with cerebral symptoms found a history of apnea in 70% of those whose birth records were available. Preston (1945) reported 132 problem children in whom asphyxia neonatorum was found in their birth history. The most striking case described was a pair of identical twins. The first born of the pair was normal but the second, which was severely asphyxiated, showed mental and behavioral defects which persisted through puberty. Evans (1948) in a study of infantile cerebral palsy found a history of asphyxia in all but one of the athetoid cases. Belknap et al (1950) in 419 cases of mental retardation or cerebral palsy found that over half had a history of birth difficuties. Darke (1944) compared the I.Q. of 16 children without neurological symptoms whose hospital records showed severe asphyxiation at birth with that of their nearest relatives and found a significant decrease in intelligence. These and other recorded data emphasize that more effort should be directed toward preventing even mild asphyxia because of the danger of brain injury.

The effects of asphyxia are well known in experimental animals. Windle and Becker (1943) found that guinea pigs recovering from experimental asphyxia neonatorum exhibit a range of neurological symptoms from cerebral palsies and epilepsy to somnolence. Less severely asphyxiated animals, which apparently had recovered completely from the treatment, still had trouble learning a maze which was easy for non-asphyxiated littermates, and forgot more rapidly (Becker and Donnell, 1952). Histological studies on these animals showed damage in the thalamus, cortex, tegmentum and cord. In some cases there was widespread reduction in cell number in the cortex (Windle, 1950, and references cited).

The use of hypothermia in asphyxia was suggested by the findings of Himwich that poikilothermia is an important factor in the resistance of mammalian fetuses to asphyxia (Fazekas, Alexander and Himwich, 1941). Also of significance are the observations of Van Harreveld and Tyler (1944) that damage, both functional and histological, to the spinal cord of cats was less after 120 minutes of asphyxiation when cooled 10°C than after 35 minutes in controls at normal temperature.

It is standard hospital practice to warm an asphyxiated baby. Since it is well known that elevation of temperature increases metabolism of cells and consequently increases need for oxygen, whereas reduction of temperature decreases metabolism, questions arise to the rationale for this procedure. Why warm an asphyxiated baby and increase its oxygen demand at a time when it is unable to get enough oxygen? Why not try cooling to decrease the oxygen demand? Many reports in the literature show excellent tolerance of low temperature by human tissues. Refrigeration is being used successfully in amputations, in heart opera-

*Based upon a report presented at the Psychology-Medicine Section of the Georgia Academy of Science, April 24, 1953, as a part of the Symposium on Cerebral Palsy.

tions and in cancer (Smith and Fay, 1941; Noble, 1948; Crosman, 1951). Cases are on record, both adult and newborn, of recovery from very low body temperature (Laufman, 1951).

Our investigation of the effects of cooling in asphyxia was begun in 1948 and preliminary findings reported (Miller, J. A., 1949; Miller, J. A., Miller, F. S., and Farrar, C. B. 1951). An extensive series of experiments has just been completed.

Asphyxial survival time was determined on over 200 newborn animals having various colonic temperatures. Cooling prolonged survival approximately 50% per 10°C decrease in temperature.

Cooling begun during asphyxiation was also effective. In these experiments the animals were dropped into ice water to the neck in the gas chamber after they had lost equilibrium from the treatment.

In recovery experiments littermates with colonic temperatures 10°C or more apart were asphyxiated until one animal died, and subsequently the other was removed and recovery of reflexes observed. Invariably cooler animals recovered from exposures lethal to warmer littermates.

A Kodachrome moving picture was made to illustrate typical experiments from the survival and the recovery series. It shows taking temperatures, cooling in ice water, asphyxiation in the gas chamber, with a time clock showing length of survival in each case, and recovery of reflexes in the case of the animal removed before gasping had stopped. The survival experiment shows a litter of three animals in which the control with colonic temperature 37.7°C lived 181 seconds, the second animal warmed to 43.°C lived 86 seconds, whereas the third cooled to 23.°C lived 346 seconds. In the recovery experiment the 23.°C animal was removed 15 seconds after the death of its 38.° littermate control. Subsequent breathing, righting and crawling of the cooled animal are shown.

It is concluded that elevation of temperature is harmful and reduction beneficial in asphyxia neonatorum in the guinea pig. These data, those on other animals and reports on humans suggest that cooling of the asphyxiated baby should be investigated. If, as appears likely, it should prove to be beneficial in human babies also, its use should reduce the number of babies developing cerebral palsies.

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SECTION II

REPORT FOR THE CHEMISTRY SECTION

By W. Joe Frierson, Secretary

The Chemistry Section program was scheduled for Friday afternoon and Saturday morning. Six papers were presented on Friday. On Saturday the Biology Section joined with the Chemistry Section for a symposium on the Teaching of Chemistry in Secondary Schools. In addition to the four scheduled speakers, several representatives from industry were present and briefly mentioned the various ways in which industry could closely cooperate with teachers and students in planning and working out projects. The hope was expressed that this symposium would serve as a spark to initiate further action toward enlarging this area of science work in the state.

The Chemistry Section business meeting was held Friday afternoon. The following officers were elected for next year:

Dr. E. Earl Royals—Chairman.

Col. J. Edgar Morris—Secretary

The Section voted that the Secretary would also be the chairman-elect.

SECTION III

REPORT OF THE EARTH SCIENCE SECTION

The Earth Science Section of the Georgia Academy of Science met in Room 3, Physics Building, with its Secretary, R. J. Martin, presiding over the scientific sessions. A number of interesting and instructive contributions were presented, divided as follows:

Georgraphy 4; Geophysics, 2; Geology, 7; Engineering 1; and Paleontology, 2.

Outstanding was the address by the rising chairman, Miss Lewis Lipps, Shorter College, Rome, Georgia. She discussed the high quality of amateur research, the country over, and pointed out that the Earth Sciences have been neglected in this program. She stressed the cultural and educational value of such studies and called attention to the work of the U. S. Department of Agriculture in this regard. Her slides dealt with her own outstanding work in Floyd and adjoining counties, Georgia, in popularizing Earth Science in the common schools and amongst the citizenry.

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